UNIVERSITI PUTRA MALAYSIA

TIDAL INFLUENCE ON THE PHYSICO-CHEMICAL PARAMETERS, TEMPORAL AND SPATIAL DISTRIBUTION OF ZOOPLANKTON IN LANGAT RIVER-ESTUARINE AREA, MALAYSIA

R.P PRABATH KRISHANTHA JAYASINGHE.

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By

R.P. PRABATH KRISHANTHA JAYASINGHE

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

June 2005

Dedication

To my mother

For her endless efforts

To give us the best life........

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairperson: Professor Fatimah Md. Yusoff, PhD

Faculty: Science

The objectives of present study were to study the water quality, zooplankton distribution and its community structure along a salinity gradient in Langat river estuarine system (2^0 46′N, 101^0 26′ E), during low and high tides. Five sampling stations from the coastal area to the upstream were chosen for this study. Station 1 was in the coastal area while Station 5 was at the most upstream, the rest of the Stations (Stations 2, 3 and 4) are located in between, passing along the river gradient. Zooplankton and water samples were collected and analyzed monthly for a period of 12 months (January to December 2003).

The water quality, nutrients and zooplankton distribution changed according to the stations and tides. The mean salinity ranged from 32.94±1.20 PSU in

coastal waters to 27.78±1.21 PSU in upstream station during high tide. During low tide, the mean salinity in the most upstream station was as low as 1.00±0.90 PSU. Higher Dissolved Oxygen values ranged (means of 5.84±0.35 to 7.09±0.13 mgL^{-1}) during high tide and it decreased (means of 3.91±0.71 to 5.22±0.71 mgL^{-1}) during low tide. On the other hand, the nutrients such as total ammonia nitrogen (ranged from 0.0014±0.001 mgL^{-1} to 2.5714±0.980 mgL^{-1}), nitrite+nitrate-nitrogen (ranged from 0.0021±0.001 mgL^{-1} to 0.8100±0.211 mgL^{-1}) and total phosphorus (ranged from 0.0712±0.024 mgL^{-1} to 0.8670±0.3241 mgL^{-1}) showed increasing trend from the coastal areas to the upstream. The highest chlorophyll *a* was recorded at Station 3 with mean values of 10.27±0.84 μgL^{-1} and 3.94±1.06 μgL^{-1} during high and low tide, respectively.

The mean zooplankton density was lowest in the coastal areas (16.21 x 10^3 ±4679.07 individuals m^{-3}) and highest in Station 4 with a mean value 119.81 x 10^3±43338.73 individuals m^{-3} during high tide. Copepods dominated zooplankton populations contributing >80% in all the stations throughout the sampling period. The other zooplankton groups such as cnidarians, appendicularians, polychaetes, ostracods, chaetognaths and shrimp larva were distributed in coastal estuarine areas whereas echinoderm larvae were restricted to coastal waters and cladocerans were found only at the upstream stations (Stations 3-5).

This study recorded 50 species of copepods which was dominated by the calanoids, *Acartia spinicauda*, *A. amboinensis* and *A. erythraea* accounting for 28%, 18% and 11% of the total copepod populations, respectively. High species diversity occurred in Station 1 decreasing towards the upstream. Species diversity varied depending on the tides, being higher during high tides and than low tides. Some copepod species were highly restricted to the high salinity levels (>30 PSU) while some species could tolerate wide range of salinity from 5 - >30 PSU. Major stenohaline species was *Oithona simplex* and major euryhaline species were *Acartia spinicauda*, *A. amboinensis* and *A. erythraea.* Zooplankton biomass study showed the highest in station 3 (dry weight 612.30±26.31 mg m^{-3} high tide) and lowest in Station 2 (150.05± 54.71 mg m^{-3} during low tide).

This study showed that water quality, nutrient concentrations and the distribution of zooplankton varied according to tides, where high tides resulted in better water quality, higher zooplankton density and higher species diversity compared to low tides. On the other hand, water quality was better and species diversity higher in coastal areas compared to other stations throughout the sampling period regardless of tides.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

KESAN AIR PASANG SURUT KE ATAS PARAMETER FIZIKO-KIMIA, TABURAN TEMPORAL DAN SPATIAL ZOOPLANKTON DI KAWASAN KUALA SUNGAI LANGAT, MALAYSIA

Oleh

R.P. PRABATH KRISHANTHA JAYASINGHE

Jun 2005

Pengerusi: Profesor Fatimah Md. Yusoff, PhD

Fakulti: Sains

Objektif kajian ini adalah untuk mengetahui kualiti air, taburan zooplankton serta struktur komuniti mengikut perubahan saliniti di sistem kuala Sungai Langat (2^0 46′N, 101^0 26′ E), semasa air pasang dan surut. Lima stesen persampelan telah dipilih bermula dari kawasan pesisiran hingga ke muara sungai. Stesen 1 terletak di kawasan pesisiran, stesen 5 terletak di bahagian hulu sungai sementara stesen lain (Stesen 2, 3 dan 4) terletak di antara kedua-dua kawasan tersebut merentasi gradien sungai. Zooplankton dan sampel air diambil dan dianalisis sekali dalam sebulan selama 12 bulan (Januari hingga Disember 2003).

Kualiti air, nutrien dan taburan zooplankton berubah berdasarkan stesen serta keadaan pasang surut. Min saliniti adalah antara 32.94±1.20 PSU di

kawasan pantai dan 27.28±1.21 PSU di stesen paling hulu semasa air pasang. Semasa air surut, min saliniti di stesen paling hulu sungai boleh turun sehingga 1.00±0.90 PSU. Nilai Kepekatan Oksigen Terlarut berada dalam lingkungan (min 5.84±0.35 hingga 7.02±0.13 mgL^{-1}) semasa air pasang dan menurun (min 3.91.0.71±0.71 hingga 5.22±0.72 mgL^{-1}) semasa air surut. Nutrien seperti jumlah ammonia- nitrogen (antara 0.0014±0.001 mgL^{-1} hingga 2.5714±0.980 mgL^{-1}), nitrit+nitrat- nitrogen (antara 0.0021±0.001 mgL^{-1} hingga 0.8100±0.211 mgL^{-1}) serta jumlah fosforus (antara 0.0712±0.24 mgL^{-1} hingga 0.8670 ±0.324 mgL^{-1}) pula menunjukkan peningkatan kepekatan dari kawasan pesisiran hingga ke hulu sungai. Nilai klorofil *a* tertinggi yang direkodkan adalah di stesen 3 dengan nilai min masing masing 10.27±0.84 μgL^{-1} dan 3.94±1.06 μgL^{-1} semasa air pasang dan surut.

Min kepadatan zooplankton adalah paling rendah di kawasan persisiran pantai (16.21 x 10^3±4679.07 individu m^{-3}) dan kepadatan adalah paling tinggi di kawasan menuju hulu sungai dengan nilai min 119.81 x 10^3±43338.73 individu m^{-3} semasa air pasang. Populasi zooplankton Copepoda menyumbangkan >80% pada semua stesen sepanjang tempoh persampelan. Kumpulan zooplankton yang lain seperti cnidarian, appendikularian, polikete, ostrakoda, kaetognath dan larva udang didapati bertaburan di sepanjang persisiran muara sementara populasi ekinodermata bertumpu di sepanjang persisiran pantai dan kladosera hanya dijumpai pada stesen di hulu sungai (Stesen 3-5).

Kajian ini telah merekod sebanyak 50 spesies kopepod yang didominasi oleh kalanoid, *Acartia spinicauda, A. amboinensis* dan *A. erythrea* masing-masing sebanyak 28%, 18% dan 11% daripada jumlah populasi copepoda. Kepelbagaian spesies yang muncul di stesen 1 didapati menurun apabila menuju ke hulu sungai. Kepelbagaian spesies yang berbeza adalah bergantung kepada keadaan pasang surut di mana kepelbagaian adalah tinggi semasa air pasang dan rendah semasa air surut. Sebahagian spesies kopepoda tertumpu bertumpu kepada saliniti yang tinggi (>30 PSU) sementara sebahagian lagi spesies boleh bertoleransi dengan julat perbezaan saliniti yang luas iaitu daripada 5 PSU hingga 30 PSU bagi. Stenohalina species yang utama adalah *Oithona simplex* dan Eurihalina species yang utama pula terdiri daripada *Acartia spinicauda, A. amboinensis* dan *A. erythraea.* Kajian biojisim zooplankton adalah paling tinggi di stesen 3 (berat kering 612.30±26.31 mg m^{-3} semasa air pasang) dan paling rendah pada stesen 2 (150.05 ± 54.71 mg m^{-3} semasa air surut).

Kajian ini menunjukkan bahawa kualiti air, kepekatan nutrien dan taburan zooplankton adalah berbeza mengikut keadaan pasang surut, di mana pada keadaan air pasang, kualiti air didapati lebih baik, kepadatan zooplankton dan kepelbagaian zooplankton adalah lebih tinggi berbanding semasa air surut. Selain itu, kualiti air adalah baik dan kepelbagaian spesies adalah tinggi di kawasan persisiran berbanding dengan stesen lain sepanjang tempoh persampelan bergantung kepada sistem pasang surut.

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I certify that an Examination Committee met on 29th June 2005 to conduct the final examination of R. P. Prabath Krishantha Jayasinge on his Master of Science thesis entitled "Tidal Influence on the Physico-Chemical Parameters, Temporal and Spatial Distribution of Zooplankton in Langat River-Estuarine Area, Malaysia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Jambari Ali, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Japar Sidik Bujang, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Abdul Rahim Ismail, PhD
Lecturer
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Mazlan Abd. Ghaffar, PhD
Associate Professor
Faculty of Science and Technology
Universiti Kebangsaan Malaysia
(External Examiner)

GULAM RUSUL RAHMAT ALI, PhD
Professor/Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 22 AUG 2005

This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirements for the degree of Master of Science. The members of the Supervisory Committee are as follows:

Fatimah Md. Yusoff, PhD
Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

Aziz Arshad, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

Mahendran Shitan, PhD
Lecturer
Faculty of Science
Universiti Putra Malaysia
(Member)

AINI IDERIS, PhD
Professor/Dean
School of Graduate Studies
Universiti Putra Malaysia

Date : 08 SEP 2005

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

R.P. PRABATH KRISHANTHA JAYASINGHE

Date: 02.06.2005

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CHAPTER I

INTRODUCTION

Background of the study

Zooplankton is a very important group of animals in aquatic ecosystems because they are the basis for food web. They constitute the important intermediate steps in the food pyramid. They transfer the organic energy produced by unicellular algae through photosynthesis to higher trophic levels such as pelagic fish stocks. Their reproductive cycles, growth, reproduction and survival rates are all important factors influencing recruitment of fish stocks (Harris *et al.*, 2000). Furthermore, zooplankton play critical role in the food intake of many invertebrates and reef fishes (Emery, 1968; Hammer and Carleton, 1979; Alldredge and King, 1980; Robichaux *et al.*, 1981; Noda *et al.*, 1998) and corals (Hammer *et al.*, 1988). Many small sized zooplankton are the main food source of carnivorous zooplanktors (Moore and Sander, 1979).

In Malaysia, marine zooplankton studies were carried out in 1928 (Keller and Richads, 1967), followed by Sewell (1933); Tham (1953); Pathansali (1968) and Tham *et al.* (1970). After that, the main focus of marine zooplankton research has gone to the Straits of Malacca (Chua and Chong, 1975; Arvin, 1977; Idris *et al.*, 2000; Johan *et al.*, 2000; Rezai, 2002; Rezai *et al.*, 2003a, 2003b, 2004a, 2004b) due to its economical, ecological and biological importance (Rezai 2002). Only a few zooplankton studies were carried out in the South China Sea (Chark and Saufi, 1987; Othman, 1988), East Coast of Malaysia (Chua, 1980; Jivaluk, 1999a) and Sabah and Sarawak coastal waters of Malaysia (Jivaluk, 1999b). Several authors have described different aspects of freshwater zooplankton in Malaysia such as copepods (Lai and Fernando, 1978) and cladocerans (Idris, 1983). These studies were mainly on species composition (Fernando, 1980a; 1980b), species distribution (Fernando, 1980c) and ecology (Lim *et al.*, 1984). Eventhough Malaysia has a vast number of estuaries, no zooplankton studies were done in those waters. Estuaries are one of the most productive ecosystems (Odum, 1971). They are important both ecologically and economically as they serve as breeding, feeding and nursery grounds for many aquatic organisms including fish (Ross and Epperly, 1985; Deegan and Day, 1985, 1986) and shrimp species (Meager *et al.*, 2003). Furthermore, estuarine ecosystems support the wildlife (Hock and Sasekumar, 1979; Smith and Odum, 1981) such as migratory birds and wild fowls.

Statement of the Problem

Estuaries represent areas of prime interest for human activities such as navigation (Carlberg, 1980), domestic and industrial garbage disposal (Carlberg, 1980; Chau, 1999; Kress *et al.*, 2002), human settlement (Day *et al.*, 1989; Wang *et al.*, 2004), fisheries and aquaculture (Jennerjahn *et al.*, 2004) and recreational activities (Baird *et al.*, 1986; Costanza *et al.*, 1997). These human activities together like deforestation, intensive agriculture, livestock farming, sand mining, river diversion and conversion of the estuarine mangroves to aquaculture ponds may alter the original structure of the estuaries and marine environment (Morton and Blackmore, 2001; Jennerjahn *et al.*, 2004). Therefore, most estuaries are threatened by human activities.

Like other estuaries in the world, estuarine areas in Malaysia have been subjected to strong anthropogenic impacts due to massive aquaculture, agriculture and siltation due to soil erosion from land base activities (Chan, 1985; Abdullah, 1995). Almost 80% of the estuaries and rivers in Malaysia are polluted (Law and Mohammad Moshin, 1980; Chye and Furtado, 1982). Many anthropogenic activities such as massive use of nutrient-rich products, especially agro-industries, have dramatically enhanced eutrophication by increasing the nutrient input into water-bodies, especially estuaries (Abdullah, 1995). Although estuaries and coastal areas in Malaysia are fast changing due to pollution, scientific studies in these areas are lacking. Deleterious effects caused by pollutants may not be remarkable in the initial stages as they are masked by dilution, especially during the high tide. However, if no effective steps are taken to reduce the pollution, eventually changes in water quality will result not only in reduced biodiversity and other undesirable ecological impacts but also creates social and economical problems. Furthermore, this will also generate problems in human health (Cato *et al.*, 1980). At the end, great costs are involved if decisions are made to clean up polluted areas and these manipulations will follow by the establishing the original ecosystem. (Cato *et al.*, 1980). Therefore, identification and quantification of the level of pollution should form an important part of managing both land and water resources within a particular river catchment (Petts and Calow, 1996).

As one of the first steps towards managing the estuarine environment, basic data on physical-chemical characteristics and biological entities are required. Similar to other ecological studies, information on zooplankton populations along river-estuaries in Malaysia is deficient. The present study focused on the temporal and spatial distribution of zooplankton in Langat river-estuarine, Malaysia, giving emphasis to its relationship with water quality parameters and nutrients. This study is important, as part of conservation of the biodiversity and results will be helpful to take sustainable management issues to reduce the pollution effects.